

# A NEW SPECIES OF CRUSTACEAN (SYNCARIDA: ANASPIDACEA: KOONUNGIDAE), FROM SINKHOLES AND CAVES IN THE SOUTH-EAST OF SOUTH AUSTRALIA

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## Summary

ZEIDLER, W. (1985) A new species of crustacean, (Syncarida: Anaspidacea: Koonungidae), from sinkholes and caves in the south-east of South Australia. *Trans. R. Soc. S. Aust.* **109**(3), 63-75, 29 November, 1985.

A new species of syncarid crustacean, *Koonunga crenarum* sp. nov. is described from sinkholes and caves near Mt Gambier, South Australia. The species occurs in surface vegetation and to a depth of 40 m. Superficially the new species resembles *K. cursor* but females are at least twice as large, reaching lengths exceeding 20 mm; the sternal process of the male petasma lacks a posterior projection and the eyes are absent. A brief description of the development of the male petasma and sensory organ on the antennule is given.

KEY WORDS: Syncarida, Anaspidacea, *Koonunga crenarum* sp. nov., South Australia, taxonomy.

## Introduction

In Australia, anaspidid syncarid crustaceans are known to occur throughout Tasmania and Victoria and an interstitial species, *Psammapides williamsi*, has been found in the New England area of New South Wales (Schminke 1974). The Tasmanian fauna is relatively diverse and to date eight species have been described. Most of mainland Australia, however, is too arid to support anaspidid syncarids and besides *P. williamsi* the only other described species are *Koonunga cursor* Sayce, 1908 and *Stygocaris giselae* Schminke, 1980. Several undescribed species of *Koonunga* are known to occur in Victoria (Drummond 1959) and also on King Island and in north-western Tasmania (Williams, W. D. 1974). It is likely that more species remain to be discovered as aquatic habitats are surveyed in more detail. *K. cursor* occurs sporadically throughout southern Victoria, usually in small permanent or semi-permanent swamps and in pools in streams which flow only after heavy rains (Drummond 1959) and it has recently been recorded from similar habitats in north-western Tasmania (De Deckker 1980). *S. giselae* is an interstitial species and is only known from the type locality, Battle Point, Tambo River, Victoria (Schminke 1980).

The species described here was found in sinkholes and caves in the Mt Gambier area, South Australia (Fig. 1). It was first recorded by Zeidler (1983) being the first record of a syncarid from South Australia. It belongs to the family Koonungidae and superficially resembles *K. cursor*.

## Materials and Methods

Specimens were collected from a number of sinkholes and caves in the south-east of S. Aust.

(Fig. 1) with a hand net from amongst algae and aquatic plants near the surface or by entrapment in a glass jar while scuba diving. The "L" number given with each locality refers to the identification number used by the Cave Exploration Group of South Australia to distinguish each cave and sinkhole in the lower south-east. A total of 236 specimens (60 ♂ and 176 ♀) were collected and examined.

Specimen length is measured from the tip of the rostrum to the tip of the telson. Specimen width is measured as the width of the third pleonite segment (usually the widest segment). Pleon length excludes the telson as the limit of the telson is obscured by spines.

Material reported here is deposited in the South Australian Museum, Adelaide (SAM), Australian Museum, Sydney (AM), Museum of Victoria, Melbourne (NMV) and the Tasmanian Museum and Art Gallery, Hobart (TM). All of the specimens are preserved in 75% alcohol or 2% formaldehyde/propylene glycol solution. Of the types only the holotype, allotype and paratype ♂ (SAM C3992) have been dissected (partially) and dissected appendages have been preserved with the carcass.

The following abbreviations are used in the text. Mxp. = maxilliped (thoracopod 1), P 1-7 = pereopods 1-7 (thoracopods 2-8), Pl 1-5 = pleopods 1-5, LHS = left hand side and RHS = right hand side when viewed dorsally.

## *Koonunga crenarum* sp. nov.

FIGS 2-7

**Holotype:** SAM C3989 (♀), collected amongst surface algae and aquatic plants in unnamed sinkhole known as "Fossil Cave" (L81), approx. 3.3 km SE of Tantanoola Caves on Princes Hwy, S. Aust. by W. Zeidler, 1.iii.1982.

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*Allotype:* SAM C3990 (♂), collected from same locality by P. Horne, 8.iii.1981.

*Paratypes:* SAM C3992 (♂) collected P. Horne, 8.iii.1981, same locality; SAM C3991 (♀), AM P35067 (♀), P35068 (♂), NMV J10809 (♀), J10810 (♂), TM G2848 (♀), G2849 (♂) collected by W. Zeidler, Lili, 1982, from same locality.

*Other material examined:* SAM C3993 (11 ♀'s), collected from type locality, at 10 m depth by P. Horne, 26.i.1981; SAM C3994 (15 ♀'s), from type locality, P. Horne, 8.iii.1981; SAM C3995 (20 ♀'s), from type locality, W. Zeidler, Lili, 1982; SAM C3996 (83 ♀'s, 45 ♂'s), from type locality, W. Zeidler and K. L. Gowlett, 16.vii.1984; SAM C3997 (1 ♀), Tank Cave (L230), just E of type locality, collected near surface by P. Horne, 6.ii.1983; SAM C3998 (1 ♂), Allendale Sinkhole (L11), centre of main road, Allendale East, approx. 20 km S of Mt Gambier, collected in total darkness at 27.5 m depth by P. Horne, 1.ii.1982; SAM C3999 (14 ♀'s), Benara Sinkhole (L32-33), near "Benara", 6 km WSW of Mt Gambier, collected at 19 m depth, by P. Horne, 12.vi.1982, SAM C4000 (1 ♀), from same locality, at 5 m depth, P. Horne, 27.xii.1984; SAM C4000 (2 ♀'s), Kilsby Hole sinkhole (L46), approx. 0.5 km W of "Burleigh"—12 km SW of Mt Gambier, collected at 30 m depth by P. Horne, 6.ii.1983, SAM C4001 (12 ♀'s, 2 ♂'s), from same locality, at 3 m depth, P. Horne, 13.ii.1983; SAM C4002 (1 ♂), Devils Punchbowl sinkhole (L47), approx. 2 km SW of "Barnoolut"—approx. 15 km SW of Mt Gambier, collected from weed at 13.7 m depth by P. Horne, 3.ii.1981, SAM C4003 (4 ♀'s), from same locality, at 40 m depth, P. Horne, 1.iii.1981; SAM C4004 (1 ♀), Walnut Cave (L33), approx. 18 km SW of Mt Gambier and 4 km due W of Mt Schank, collected at 3 m depth by P. Horne, 20.ii.1981; SAM C4005 (2 ♀'s), Gums Road Cave (L63), approx. 4.5 km NE of Kangorong—20 km SW of Mt Gambier, collected near surface by P. Horne, 26.ix.1982; SAM C4006 (2 ♂'s), Bonlebrush Sinkhole (L64), in Caroline Forest, approx. 15 km SSE of Mt Gambier, collected at 10 m depth by P. Horne, 12.x.1982; SAM C4007 (1 ♀), Hereford-Stream Cave (L71), approx. 6 km E of Ewens Ponds—23 km SSE of Mt Gambier, collected near surface by P. Horne, 22.xi.1982; SAM C4008 (1 ♀, 1 ♂), Mudhole sinkhole (L97), Tantanoola Forest, approx. 6 km SE of Tantanoola Caves, collected at 6 m depth by P. Horne, 31.i.1982; SAM C4009 (2 ♀'s, 1 ♂), Alleyns Cave sinkhole (L84/85), just E of Mudhole, collected near surface by P. Horne, 30.xii.1983; SAM C4010 (1 ♀), McKay Shaft sinkhole (L125), 3 km W of Valley Lake, Mt Gambier, collected at 3 m depth by P. Horne, 11.xii.1982; SAM C4011 (1 ♀), Mushroom Cave (L132), approx. 2 km E of Ewens Ponds, collected at 3 m by P. Horne, 22.xi.1982; SAM C4012 (1 ♀), unnamed sinkhole (L144), in Mt Gambier Forest, approx. 2 km NW of Mt Gambier Airport, collected near surface by P. Horne, 14.ii.1982; SAM C4013 (1 ♂, 1 ♀), The Shall sinkhole (L158), approx. 3 km W of Allendale East, collected at 5 m depth by P. Horne, 14.iii.1984; SAM C4014 (1 ♀), from same locality, at 3 m depth, P. Horne, 4.ii.1984; SAM C4015 (1 ♀), The Bullock Hole sinkhole (L163), on "Barnoolut" property—approx. 14 km SW of Mt Gambier, collected at 27.5 m depth by P. Horne, 6.ii.1982; SAM C4027 (4 ♀'s, 1 ♂), Glencoe West Cave (L77), approx. 11 km NE of Tantanoola Caves, collected at 2 m depth by A. Cox and P. Horne, 29.xii.1984; SAM C4029 (1 ♀), Englebrechts Cave (L19/20), Mt Gambier, collected at 9 m depth by A. Cox, 23.iii.1985.

Specimens have also been sighted in Morgans Cave (L34) and The Pines Cave (L61), both near

Alleysn's Cave; Hells Hole sinkhole (L40) just north of Bottlebrush Sinkhole and Simpsons Hole sinkhole (L42) between Devils Punchbowl sinkhole and Gums Road Cave (Fig. 1).

*Description of holotype:* Female measuring 18.3 mm total length, 3.4 mm width. General appearance illustrated in Fig. 2. First thoracic somite fused with head. Pereon with seven free somites and pleon with six free somites and a telson. All body somites with one pair of appendages. Anus opens at posterior limit of pleonite 6. Pleon (excluding telson) longer (7.7 mm) than pereon (6.2 mm) and broader than pereon and head. Head length equivalent to first  $3\frac{1}{2}$  pereonites, broader than pereonites 1-4, equal to pereonite 5 and narrower than pereonites 6 and 7. Pleonite 6 longest body segment, pleonites 1-3 broadest. Pleonite 6 with row of six well spaced spines near dorsalmost border interspersed with 1-2 fine setae. Body segments progressively more robust from anterior to posterior to about pleonite 4.

*Head:* rectangular ( $3.2 \times 2.8$  mm) with short, pointed rostrum and distinct antero-lateral incision above attachment of antenna. Pronounced short mid-lateral transverse sulcus. Eyes absent but pigment more concentrated near antero-lateral incision.

*Antennule* (Fig. 4a): peduncle of three segments, outer flagellum of 56 (LHS) and 48 (RHS) segments and inner flagellum of 16 (LHS) and 15 (RHS) segments. Outer flagellum about  $3.5 \times$  length of inner. Peduncle and outer flagellum as long as  $3/4$  body length. Basal segment of peduncle broader, almost as long as following two combined. Basal segment of outer flagellum with oblique dorsally serrated inner margin. Presence or absence of statocyst in basal segment of peduncle could not be determined with certainty.

*Antenna* (Fig. 4b): slightly more than  $2/3$  length antennule; peduncle of 4 segments and single flagellum of 35 segments (LHS & RHS). Basal segment short, segments 2-4 elongate, rectangular, segment 3 longest.

*Upper lip* (Fig. 3a): rows of short bristles on both sides at extremity and small central depression on aboral surface near extremity.

*Mandibles* (Figs 3c-f): 3-segmented palp; middle segment greatly enlarged, about twice length basal segment; terminal segment small, rounded; feathered setae along inner margin of segment 2, apically on segment 3. Base of mandibles stout, ending in well developed molar and incisor process. Molar process with small grinding surface surrounded by numerous spiniform setae. Incisor process of left mandible with seven denticles arranged in "S"-shaped row, denticle nearest molar

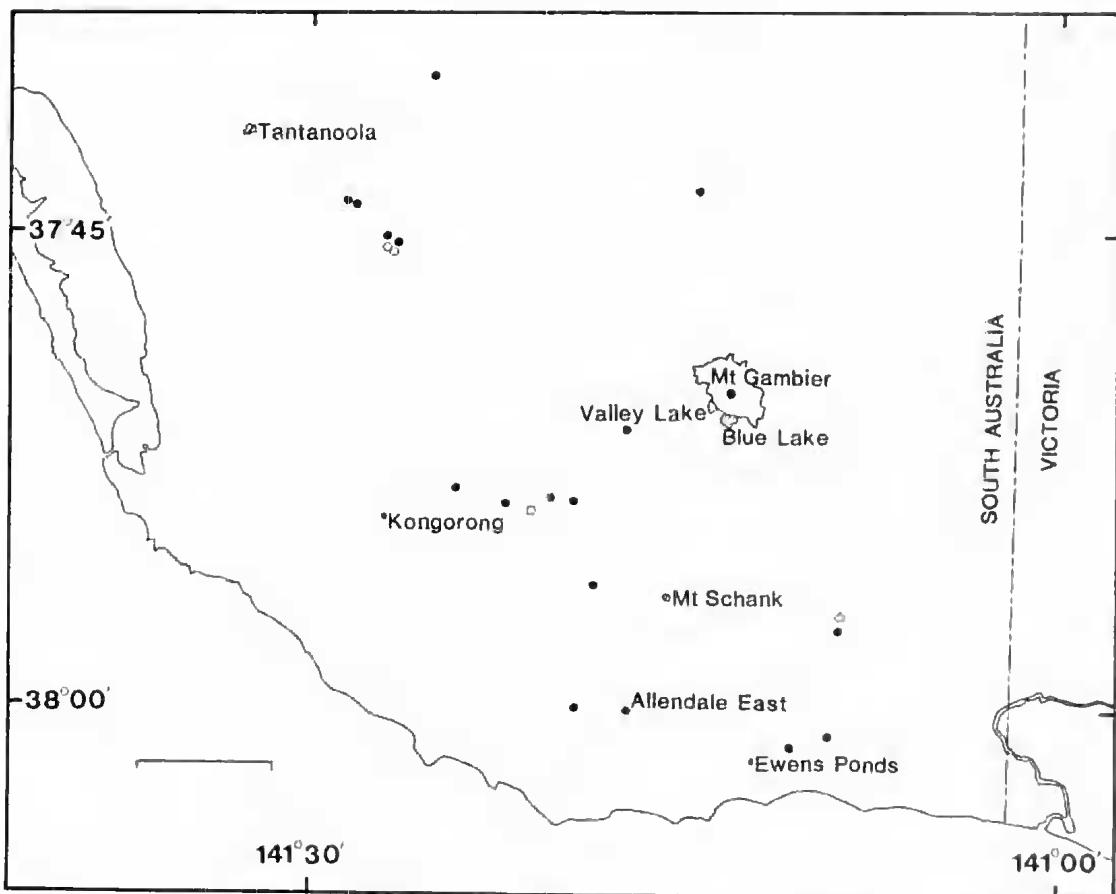


Fig. 1. Localities where *Koonunga crenarum* sp. nov. has been collected (●) or sighted (○). Scale bar — 5 km.

reduced. Incisor process of right mandible with five denticles arranged in "C" shaped row overlapping left mandible when viewed aborally. No evidence of secondary cutting plate or spine row.

Lower lip (Fig. 3b): bilid with deep central groove; inner lobes well developed; outer lobes upright almost perpendicular to aboral surface. Distal margin of lobes and part of lip covered by long setae, particularly on aboral surface.

First maxilla (Fig. 3h): two lobed. Outer lobe with small, one-segmented palp with three long, terminal spinules, partially feathered along inner margin. Extremity of outer lobe obliquely truncated with twelve strong, chitinous (?) spines, some stouter than others and two smaller feathered spines near the aboral surface. Inner lobe about 1/2 width of outer lobe with one long, stout feathered spine near oral surface surrounded by eight smaller feathered spines.

Second maxilla (Fig. 3g): smaller than first consisting of four lobes; inner one smallest, others increase successively in length and width. Inner two

lobes covered with short bristles or setae. Inner lobe with six feathered spinules of varying lengths terminally. Other lobes with more numerous (>10) but similar terminal spinules which fan out laterally to oral and aboral surface.

Maxilliped (thoracopod 1) (Fig. 4c): stout limb of seven segments flexed posteriorly between merus and carpus. Coxa shorter and wider than following segments with two adjacent branchial lamellae (epipodites) near outer, aboral corner. Basis with exopodite of two joints resembling branchial lamellae along outer, aboral margin and with several fine setae near distal, oral margin. Ischium with slight expansion distally, slightly wider and longer than basis, with several long, fine setae on oral surface near inner margin and clustered on outer aboral corner. Merus inflated proximally, longer than any other segment, only slightly narrower than coxa; with long fine setae scattered over oral surface but more numerous near inner margin. Carpus, smallest joint with row of long setae along distal, oral margin for inner half and on oral and aboral

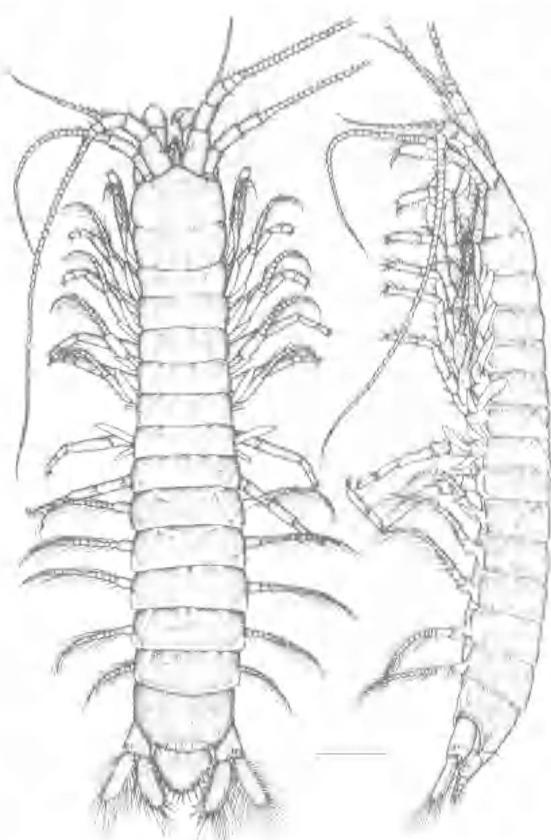


Fig. 2. *Koonunga crenarium* sp. nov. holotype ♀. Scale bar = 2 mm.

outer distal margin. Propodus robust, slightly shorter than merus, with two oblique rows of strong spines on oral surface and tuft of long setae on aboral, distal, outer corner. Dactylus small, rounded, armed terminally with one large and three smaller strong claw-like spines and few setae near inner margin.

Pereiopods (thoracopods 2–8) (Figs 4f–l): similar in structure to Mxp but with basis expanded proximally, almost as wide as coxa and becoming progressively more slender with all segments more elongate. P1 slightly shorter than Mxp but slightly longer than P2 & P3 of equal length. P4 as long as Mxp and longest pereiopod. P5 shortest, P6 slightly longer than P5 but slightly shorter than P2 or P3. P7 similar in length to P1. All pereiopods flexed between merus and carpus and in backward position except for P6 which flexes inwards and P7 which flexes forwards. Coxa with setose lobe near inner, distal corner barely recognisable on P1 but progressively developed to maximum on P6 but absent on P7. Pl-6, coxa with two unequal epipodites as in Mxp. Pl-5, basis with multi-

segmented exopodite consisting of large basal segment reaching well past ischium and flagellum of 14–16 segments (Table 1) each segment bearing two long feathered setae. P6, basis without exopodite, P7 without epipodites or exopodite. Dactyl claws similar to Mxp but P5–7 have one additional claw. Spermatheca: two small, ovoidal plates, slightly raised from the sternum just forward of base of P7 on last pereonite (Fig. 5a).

Pleopods (Figs 5b–f): all of similar structure, lacking endopodites but with long multi-segmented exopodites consisting of short-stout basal joint followed by longer more slender one and flagellum of 15 segments in Pl 1–4 and 13 segments in Pl 5, each bearing two long feathered setae. Pl 1–3 equal in length and longest pleopods. Pl 4 slightly shorter and Pl 5 shortest, about 3/4 length Pl 1–3. Pl 1–3 also flattened laterally, Pl 4 & 5 round in cross-section.

Uropods (Fig. 5h): peduncle stout, rectangular, as long as telson and almost 3/4 length pleonite 6 (measured ventrally), projecting to slightly more than 1/3 telson length; few scattered short spines on dorsal surface and near outer margin. Outer ramus almost 1 1/4 peduncle length, slightly longer than inner ramus, with long feathered setae along inner and outer margins and row of short strong upturned spines near outer dorsal margin. Inner ramus with long feathered setae along outer margin and partly terminally, remaining terminal margin with three (LHS) or four (RHS) long spines; dorsal inner margin with row of strong upward curved spines for about proximal 2/3, steadily increasing in size terminally followed by comb of smaller spines, ceasing at first terminal spine.

Telson (Fig. 5h): triangular in shape with rounded apex and slightly convex lateral margins; length (excluding spines) slightly less than width; margins with complex array of spines except for proximal 1/4, consisting of close-set fringe of short, stout spines ventrally, 20 evenly spaced, long spines directed posteriorly and about 14 slightly shorter spines directed dorsally interspersed with 1–2 fine setae.

Colour: light tan with some specimens darker than others. Those captured in deeper water and in total darkness do not vary in colour from those caught near the surface. Preserved specimens only slightly faded to date.

*Description of allotype:* Male measuring 14.8 mm in total length and 2.5 mm in width, essentially similar to holotype except for the following differences.

Antennule (Fig. 4c): with characteristic oval-shaped sensory organ arising from second segment of outer flagellum. Basal segment of inner flagellum saucer-shaped shielding sensory organ. Outer flagellum of



Fig. 3. *Koonunga crenarum* sp. nov. holotype ♀, mouthparts. a. upper lip; b. lower lip; c. mandible RHS, aboral view; d. mandible LHS, aboral view; e. mandible LHS, oral view; f. mandible, RHS, oral view; g. maxilla 2; h. maxilla 1; Scale bar = 0.2 mm.

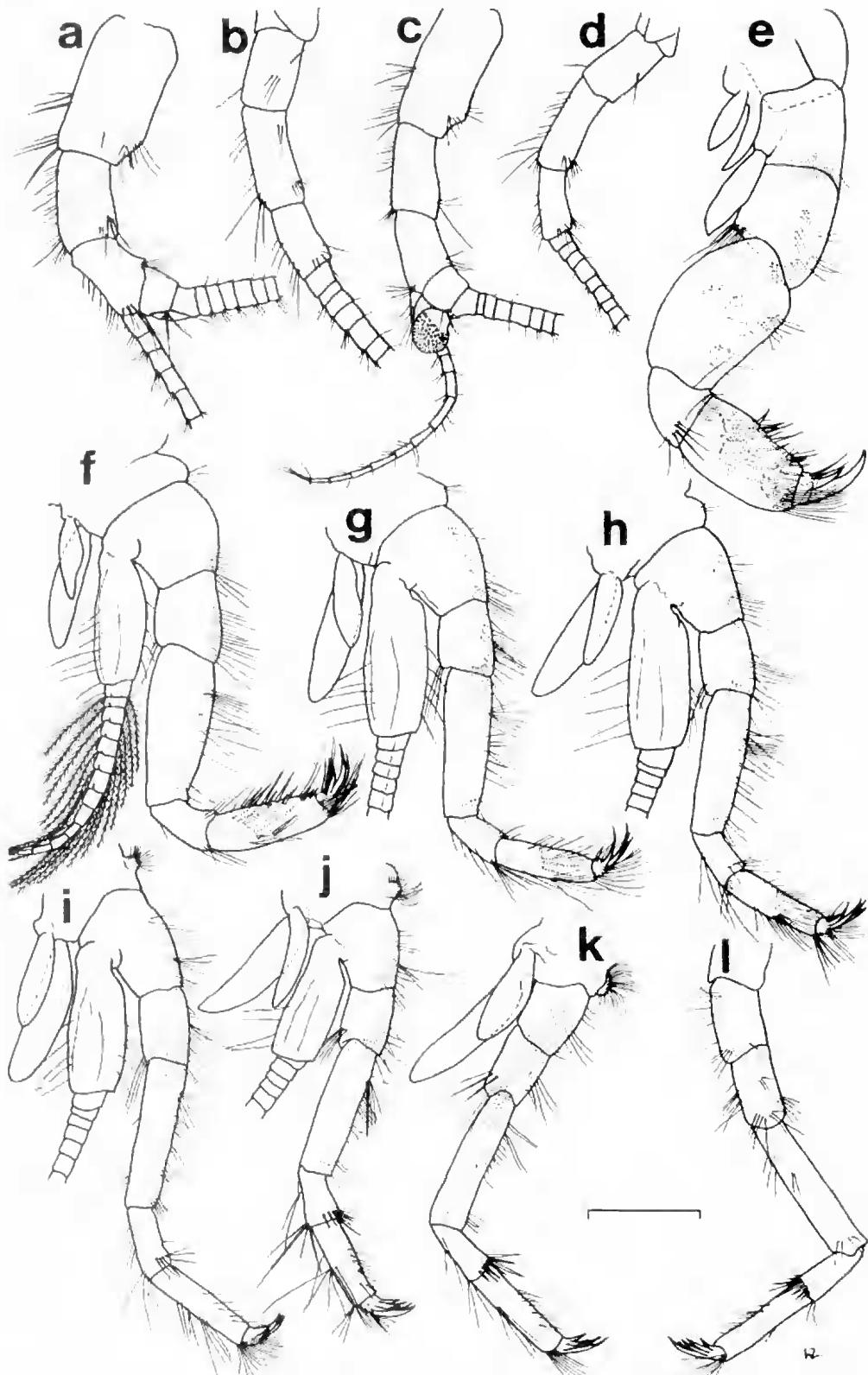


Fig. 4. *Koonunga crenarium* sp. nov. holotype ♀. a. antennule; b. antenna; c. antennule, allotype ♂; d. antenna, allotype ♂; e. Mxp; f-l = PI-7. Scale bar = 1 mm.

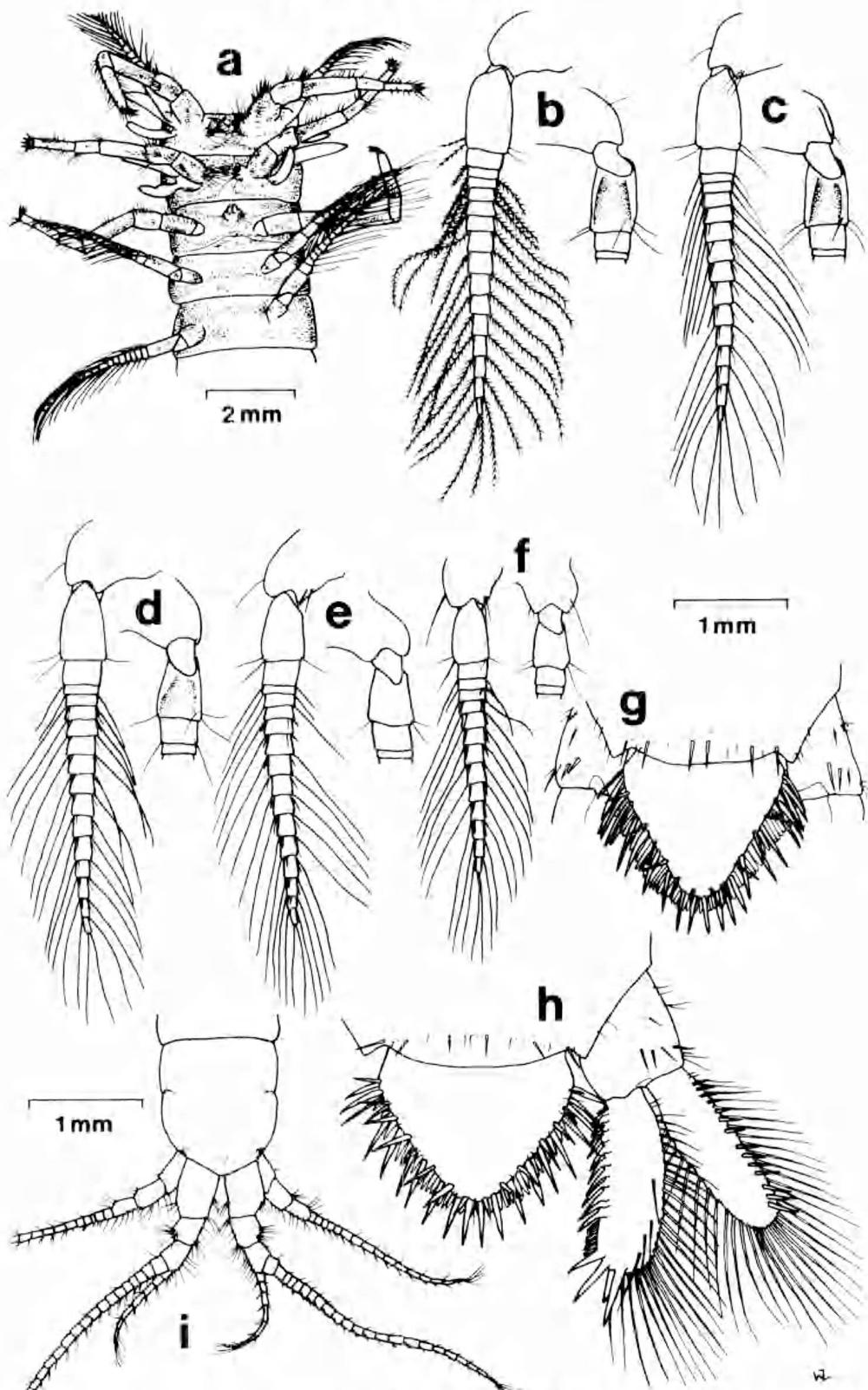


Fig. 5. *Koonunga crenarum* sp. nov. a. spermatheca, ♀ (SAM C3991); b-f = Pl 1-5 holotype ♀; g. telson, allotype ♂; h. telson and uropod, holotype ♀; *K. cursor*; i. anterior of ♀ specimen (8.2 mm) from Railway Drain, Bayswater, Vic. (SAM C4016).

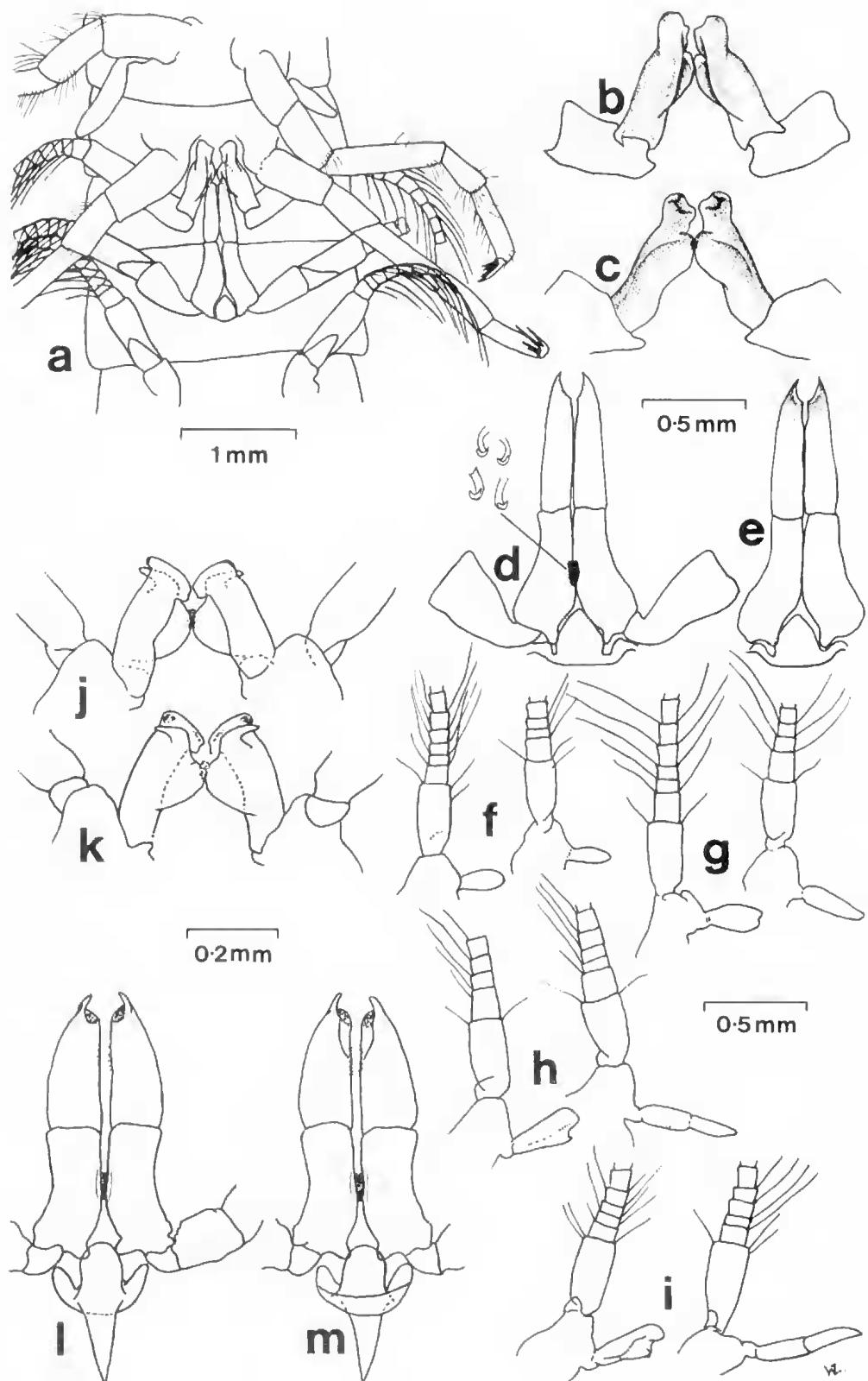


TABLE I. Meristic data for *Koonunga crenarum* sp. nov. holotype (H), allotype (A) and paratypes (P). All measurements from dorsal aspect. Unless indicated otherwise the number of segments refer to the flagellum. "D" = damaged or broken.

Character	H ♀ C3989	A ♂ C3990	P ♀'s	P ♂'s
Length (mm)				
Head	3.2	2.8	3.0 - 3.7	2.0 - 2.4
Pereon	6.2	4.6	5.5 - 6.7	3.4 - 5.0
Pleon	7.7	6.2	6.7 - 8.3	4.4 - 5.8
Telson	1.2	1.2	1.0 - 1.5	0.7 - 1.1
Total	18.3	14.8	16.5 - 20.2	10.5 - 14.3
Antennule LHS (RHS)	13.5 (13.6)	9.9D (13.1)	10.9 (11.6)-14.9D (13.7D)	8.4 (8.2)-12 (10.3D)
Antenna LHS (RHS)	8.6 (9.6)	7.5 (7.1D)	7.5 (7.4)-10.5 (10.4)	5.4 (5.1)-7.5 (7.8)
Ratio Pleon/Pereon	1.24	1.35	1.17-1.25	1.16-1.32
Breadth (mm)				
Head	2.8	2.3	2.3 - 3.1	1.6 - 2.1
Pereonite 7	3.2	2.4	2.5 - 3.0	1.8 - 2.3
Pleonite 3	3.4	2.5	2.8 - 3.2	2.0 - 2.6
Telson	1.7	1.45	1.5 - 2.0	1.1 - 1.3
Antennule (segments)				
Inner ramus LHS (RHS)	16 (15)	14 (14)	15 (15)-17 (16)	7D (11)-14 (15)
Outer ramus LHS (RHS)	56 (48)	39D (59)	45 (50)-57 (57)	43 (43)-55 (43D)
Antenna (segments)				
LHS (RHS)	35 (35)	27 (33D)	34 (28)-40 (40)	24 (24)-33 (37)
Pereopods (segments/exopodite)				
1 LHS (RHS)	14 (14)	13 (13)	13 (13)-15 (15)	10 (10)-12 (12)
2 LHS (RHS)	15 (15)	D (15)	15 (15)-17 (18)	11 (12)-14 (14)
3 LHS (RHS)	16 (15)	16 (16)	15 (15)-18 (D)	12 (12)
4 LHS (RHS)	15 (15)	15 (D)	15 (15)-17 (18)	12 (11)-14 (12)
5 LHS (RHS)	15 (15)	15 (D)	14 (14)-17 (16)	11 (11)-14 (14)
Pleopods (segments)				
1 LHS (RHS)	15 (15)	15 (15)	15 (15)-16 (16)	11 (11)-14 (13)
2 LHS (RHS)	15 (15)	15 (15)	15 (15)-16 (16)	11 (11)-14 (14)
3 LHS (RHS)	15 (15)	15 (D)	15 (15)-16 (D)	11 (11)-14 (14)
4 LHS (RHS)	15 (15)	15 (D)	15 (14)-16 (D)	11 (11)-13 (14)
5 LHS (RHS)	13 (13)	13 (13)	13 (13)-14 (14)	9 (D)-12 (12)
Uropod spines				
Inner ramus—inner dorsal LHS (RHS)	12 (12)	11 (12)	13 (13)	11 (11)-12 (12)
Outer ramus—outer dorsal LHS (RHS)	D (14)	18 (17)	15 (15)-17 (17)	13 (13)-18 (17)

59 segments (RHS; LHS broken); inner flagellum of 14 segments (LHS & RHS).

Antenna (Fig. 4d): left with flagellum of 27 segments, right broken but still with 33 segments.

Pereopods: similar to holotype but all with four dactyl claws. PI-6 without coxal lobes.

Pleopods: 1 and 2 with endopodites modified to form complex copulatory styles (petasma). Petasma (Fig. 6a) directed anteriorly against mid-ventral surface between, and posterior to, last pair of pereopods.

Endopodite of PI 1 (Figs 6b, c) unsegmented, grooved for about middle half of external inner margin to provide sleeve for endopodite of PI 2; cup-shaped terminally, directed inwards and towards body. Endopodites joined about 2/3 from base by

coupling spines on extension of internal, inner margin.

Endopodite of PI 2 (Figs 6d, e) of 2 segments of about equal length, each as long as endopodite of PI 1. Basal segment slightly expanded proximally with coupling spines on small pad near centre of internal, inner margin and with small basal projection on inner proximal corner articulating with sternal process. Distal segment apically pointed, hollowed out on distal, inner margin to form concave depression directed towards body.

Sternal process (Figs 6d, e): triangular in shape, slightly longer than wide, slightly less than 1/2 length of basal segment of endopodite of PI 2, fitting inbetween basal 1/4 of endopodites of PI 2.

Telson (Fig. 5g): slightly more pointed apically than

Fig. 6. *Koonunga crenarum* sp. nov. a. petasma, allotype ♂; b. endopodite PI 1 ventral view; c. reverse of b; d. endopodite PI 2; e. reverse of d; f-i. endopodites PI 1 (LHS) & PI 2 (RHS) of specimens 7.9, 8.4, 9.3 & 10.1 mm length respectively; K. cursor: ♂ 6.6 mm (SAM C4016); j. endopodite PI 1; k. reverse of j; l. endopodite PI 2; m. reverse of l.

in type, lateral margins straight or even slightly concave.

**Etymology:** From Greek mythology, "crenæ" being nymphs of springs.

**Variation:** The paratypes are similar to the type or allotype. Variation in size and other meristic characters is shown in Table 1. Not shown in Table 1 is slight variation in the number of dactyl claws on the pereopods, the number of large terminal spines of the inner ramus of the uropods and the relative lengths of the pereopods and pleopods. The pereopods usually have four dactyl claws but sometimes in the larger specimens P4-7 may have five dactyl claws e.g. holotype and female paratype SAM C3991. The inner ramus of the uropods usually has three large terminal spines but in SAM C3991 and on RHS of the holotype there are four spines. The pereopods and pleopods have not been measured for each specimen and show only slight variations from the holotype. In the male SAM C3992, P2 & 7 are the longest and P4-6 are the shortest, equal in length and slightly shorter

than the Mxp; the pleopods are like those of the holotype.

The non-type material exhibits the same variation. Specimens from various localities have been examined in detail, and cannot be distinguished from those from the type locality.

Some specimens appear to be more slender than others and at first it was thought that two species might be present, however, the relationship between length and breadth shown in Fig. 7 indicates that breadth is a variable character especially in larger specimens. The pleon/percon ratio is also variable, ranging from 0.99 to 1.77 but does not appear to be related to length, breadth or sex of specimens.

Females varied in length from 5.9 to 22.6 mm with a mean length of  $13.8 \pm 0.5$  mm ( $\pm 95\%$  c.l.). Males ranged in length from 7.8 to 16.2 mm with a mean length of  $10.9 \pm 0.5$  mm ( $\pm 95\%$  c.l.) which is significantly smaller than that of the females ( $P < 0.01$ ). The female sample is larger (176/60 ♀♂). However, seasonal fluctuations in the proportion of males in the population may account for some

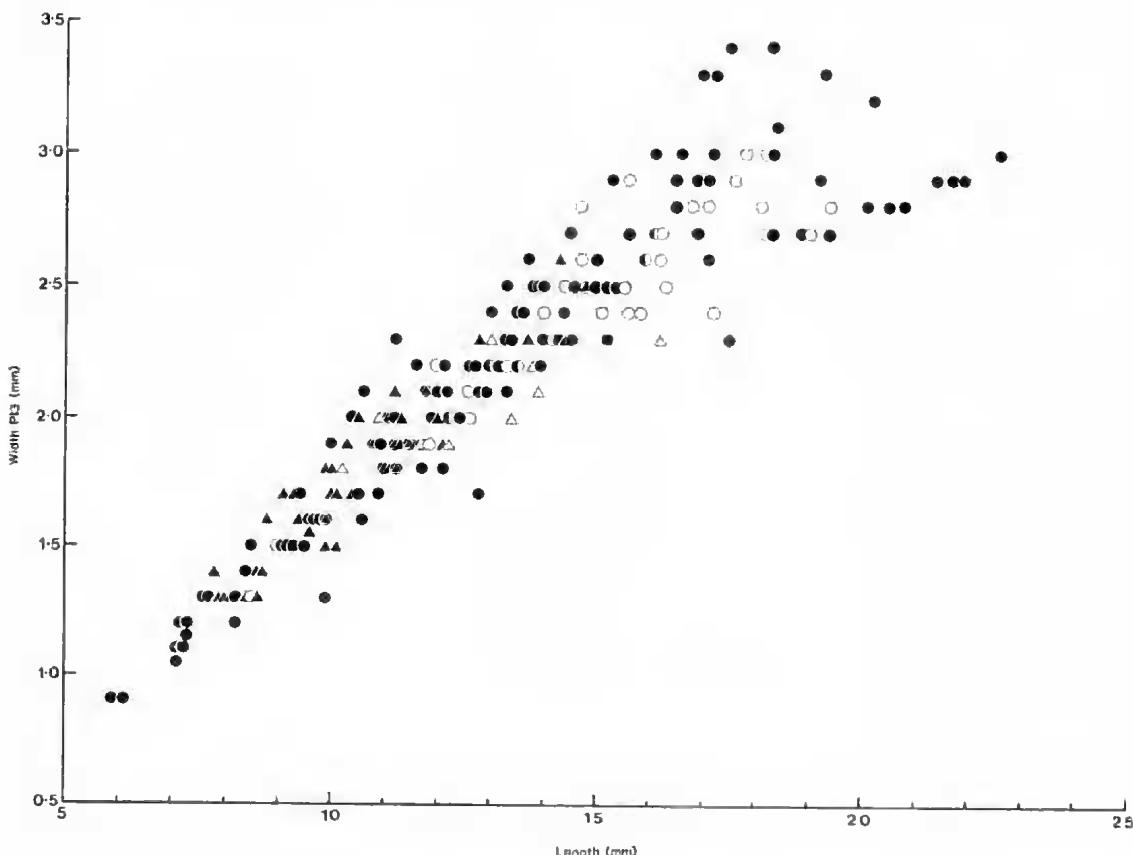


Fig. 7. *Koonunga crenarum* sp. nov. Relationship between length and breadth (pleonite 3). Females closed circles, males closed triangles; open symbols refer to specimens from localities other than the type locality.

of the observed imbalance as 45/128 specimens were males in July, 1984 compared to 0/11 in January, 1981; 2/17 in March, 1981 and 3/28 in March, 1982—all from the type locality.

#### *Development of the petasma and sensory organ of male*

A relatively large collection of males from the type locality in July, 1984 (SAM C3996) included a number of very small specimens which exhibited various stages in the development of the petasma and also the sensory organ of the antennule. The development of these sexually dimorphic characters in syncarids has not been reported in the literature.

The endopodites of PI 1 and PI 2 develop laterally from the base of the pleopods until they overlap and are fully developed; they are then directed longitudinally forward but are not linked by the coupling spines until the sternal process is also fully developed. The earliest stage observed was at a length of 7.9 mm (Fig. 6f). At this stage the endopodites are only recognisable as single, small, rounded segments and the sternal process is not visible. In the next stage at 8.4 mm (Fig. 6g) the endopodite of PI 1 is beginning to differentiate but the sternal process has not developed further. At 9.3 mm (Fig. 6h) the endopodite of PI 1 is beginning to form its characteristic shape; the endopodite of PI 2 has divided into two segments and the sternal process is recognisable as a small ridge. At 10.1 mm (Fig. 6i) the endopodite of PI 1 is almost fully developed with coupling spines; the endopodite of PI 2 is also almost fully developed but lacks the concave depression at the tip and the sternal process has not developed further. A specimen at 9.6 mm had a fully developed petasma and sternal process but the endopodites of PI 2 were still not linked by coupling spines. Other specimens at about 10 mm exhibited fully developed male sexual characteristics.

The sensory organ on the antennule arises from a depression on the inner margin of the second segment of the outer flagellum (Figs 8a, b) and develops into a pedunculate eye-like organ with the rounded outer surface covered with minute cup-like structures attached to the surface by a short stalk (Fig. 8e). The basal segment of the inner flagellum becomes modified developing a saucer-shaped lobe on the dorsal surface which partly shields the sensory organ (Figs 8d, e). The earliest stage observed was at a length of 8.4 mm (Figs 8a, b). At this stage the sensory organ is only a small protuberance and the basal segment of the inner flagellum is undifferentiated. At 9.3 mm (Fig. 8c) the sensory organ has developed into a ball-shaped structure but the basal segment of the inner flagellum is still unmodified. At 10.1 mm (Fig. 8d) the sensory organ is larger and more pedunculate and the basal segment of the inner flagellum is beginning to differentiate forming a small lobe on the dorsal surface. A specimen at 11.3 mm (Fig. 8e) had an almost fully developed sensory organ and the basal segment of the inner flagellum had become broader and saucer-shaped with a fringe of long setae on the dorsal margin, partly shielding the sensory organ.

Sayce (1908) in his description of *K. cursor* described and illustrated the sensory organ arising from the basal segment of the outer flagellum and a saucer-shaped lobe shielding the sensory organ as arising from the terminal segment of the peduncle. An examination of some specimens of *K. cursor* from Bayswater, Victoria (SAM C4016) demonstrate that these male sexual characters (Fig. 8f) are similar to those of *K. crenatum* sp. nov. and that Sayce (1908) was in error in his determination of these features.

In view of the above it is possible that specimens less than 8 mm in length may be difficult to sex but as only 10 females were this small it would make little difference to the proportion of males/females observed.

TABLE 2. *Distinguishing characters of Koonunga cursor and K. crenatum sp. nov.*

Character	<i>K. cursor</i>	<i>K. crenatum</i>
Specimen length ♀	rarely exceeds 10 mm	exceeds 20 mm
Antennule length	approx. 1/2 body length, when attached barely reaches pereonite 3.	approx. 1/4 body length, when attached reaches past pereonite 7.
Head	evenly rounded anteriorly, antero-lateral incision above antenna very small (Fig. 5i)	pointed anteriorly, antero-lateral incision above antenna distinct (Fig. 2)
Eyes	small but present	absent
Petasma (♂)	sternal process with large posterior projection (Figs 6l, m) Note also distinctive structure of endopodites of PI 1 & 2 (Figs 6j-m)	sternal process without posterior projection (Figs 6d, e) Note also distinctive structure of endopodites of PI 1 & 2 (Figs 6b-c)
Dactyl spines	P 1-7 = 3	P 1-3 = 4, P 4-7 = 4-5

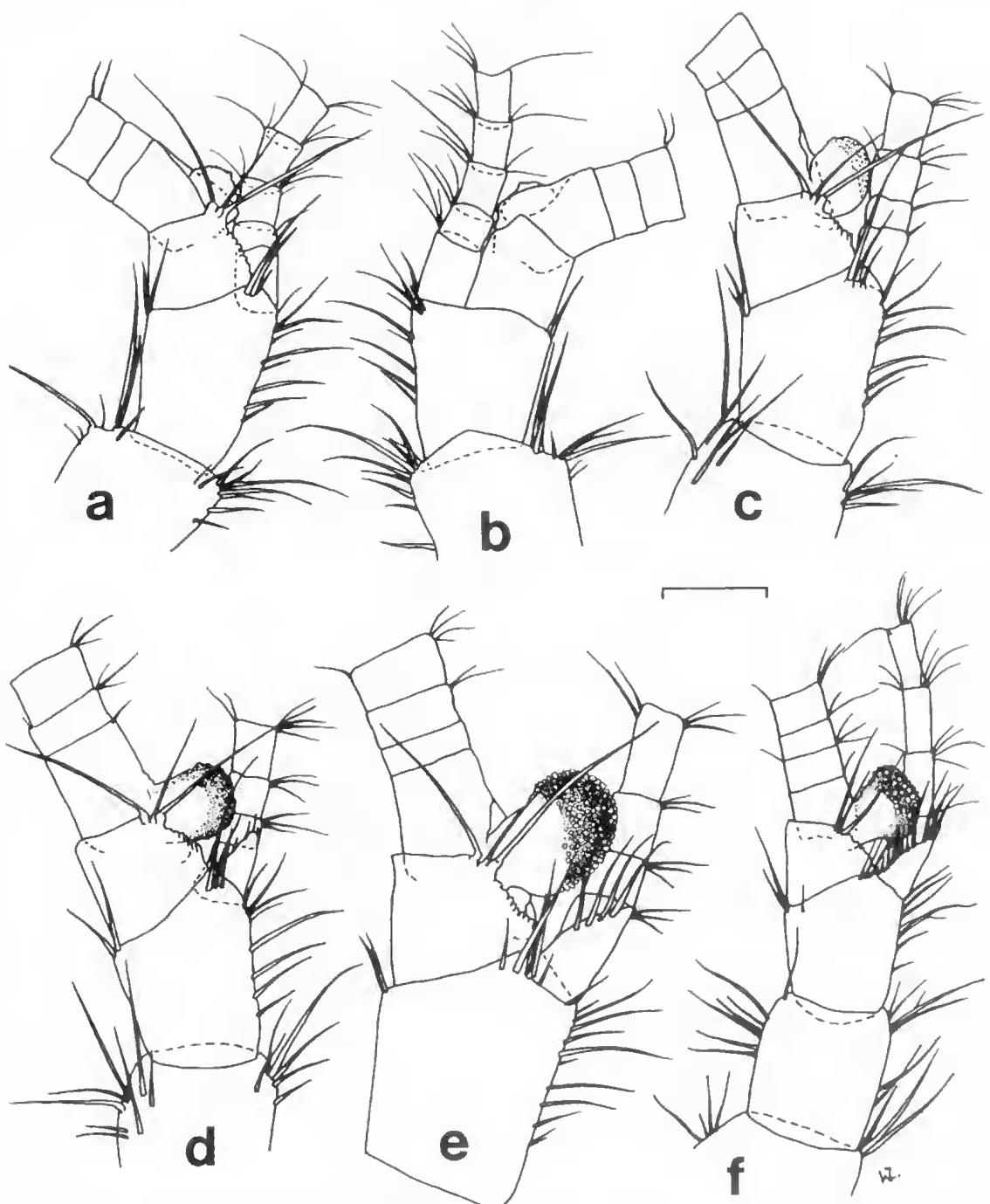


Fig. 8. Sensory organ on antennule (LHS) of—*Koonunga crenarum* sp. nov. (SAM C3996) a & b. dorsal and ventral view, from specimen 8.4 mm; c-e = dorsal view, from specimens 9.3, 10.1 & 11.3 mm length respectively.—*K. cursor* (SAM C4016) f. dorsal view, from specimen 6.6 mm. Scale bar = 0.2 mm.

### Discussion

*Koonunga crenarum* most closely resembles *K. cursor* the only other described congener and can most readily be distinguished from it by the characters given in Table 2. In the lack of eyes it also resembles *Micraspides calmani* Nicholls, 1931, the only other member of the family Koonungidae.

*K. crenarum* amongst the Koonungidae (including known undescribed species) occupies the most subterranean habitat and is also the largest species. It occurs in depths exceeding 40 m and of particular significance is its occurrence in sinkholes that were only discovered when the roof collapsed e.g. Allendale and The Shaft. All previous records of Australian syncarids are from relatively shallow depths and even the Tasmanian syncarids which inhabit lakes tend to occur near the edges and the deepest record is 8 m, recorded for *Paranaspides lacustris* Smith, 1909 (Williams, W. D. 1974).

As sinkholes and caves are difficult and dangerous environments to explore it is hard to establish the relative abundance of the species with depth although it would seem to be more abundant in the surface waters, especially near vegetation at the edges of the sinkhole or cave. Specimens from the surface and deep water have been compared in detail and appear to be conspecific; pigmentation is similar but deep water specimens are slightly darker. *K. crenarum* does not appear to be a strong swimmer so it is unlikely that regular migrations occur between the surface and the bottom of the sinkholes. It is unlikely that the deep water specimens represent individuals that have become "lost" as many more specimens have been sighted in deep water than have been collected (P. Horne, pers. comm.). *K. crenarum* therefore most probably occurs throughout the depth of sinkholes and caves.

The occurrence of *K. crenarum* in several, sometimes widely separated, sinkholes and caves (Fig. 1) suggests that these environments must have been linked at some time in the past. An underground connection has been a popular theory but is not supported by hydrological evidence (Holmes & Waterhouse 1983) and the animals are too large for

interstitial travel. It is most likely that the habitats were once connected by flood waters although they are not located near flats which were subject to annual flooding before drainage (Williams, M. 1974). It is possible that they were isolated before European settlement. Whatever the connection in the past sinkholes and caves are now isolated refuges for a once more widespread fauna.

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